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ceiling or wall from as diaphragm

(3 SHEETS)
SHEET 1.

Fig:1.

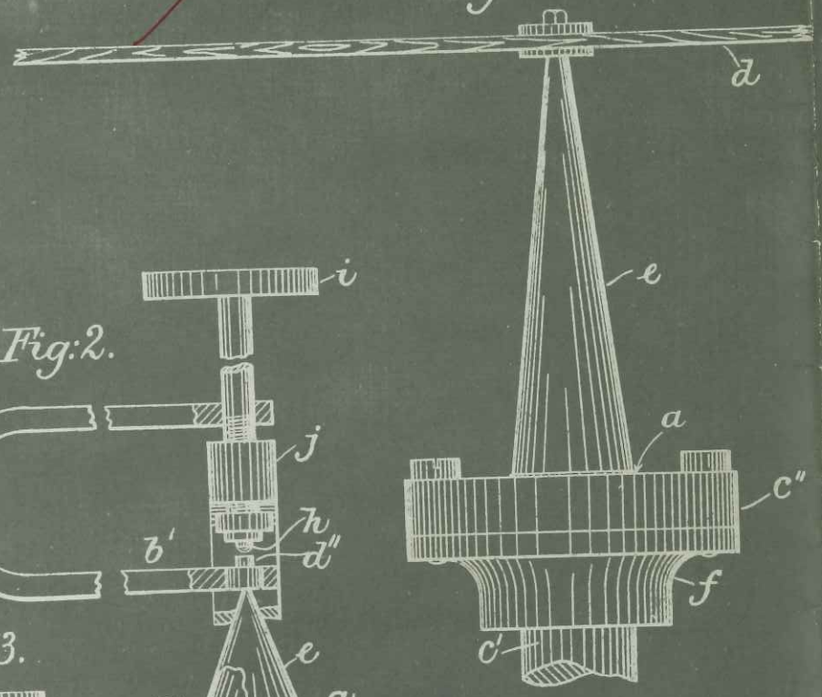


Fig:2.

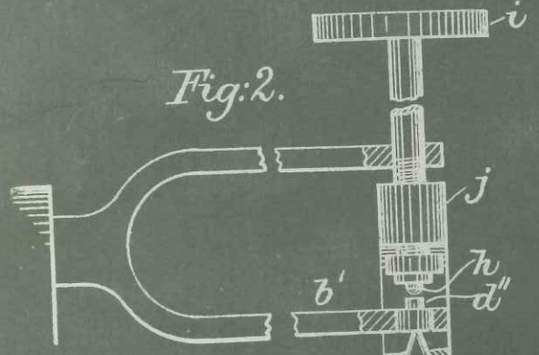


Fig:3.

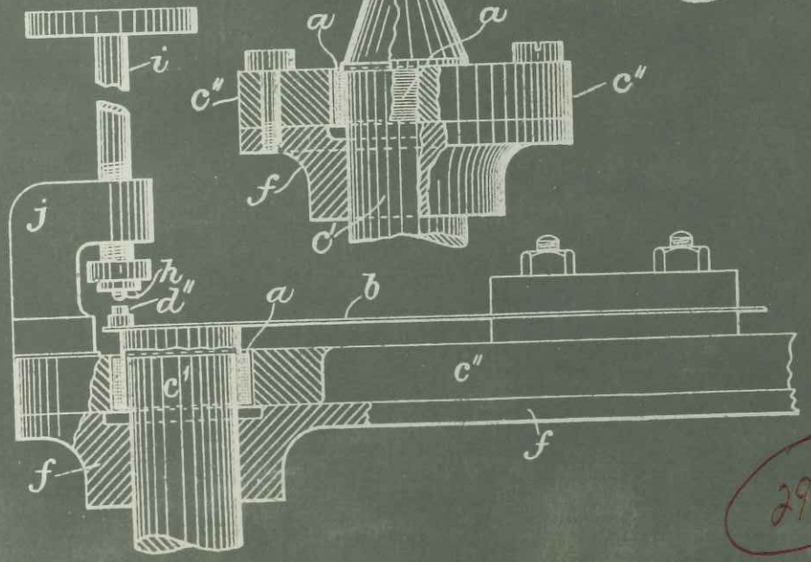
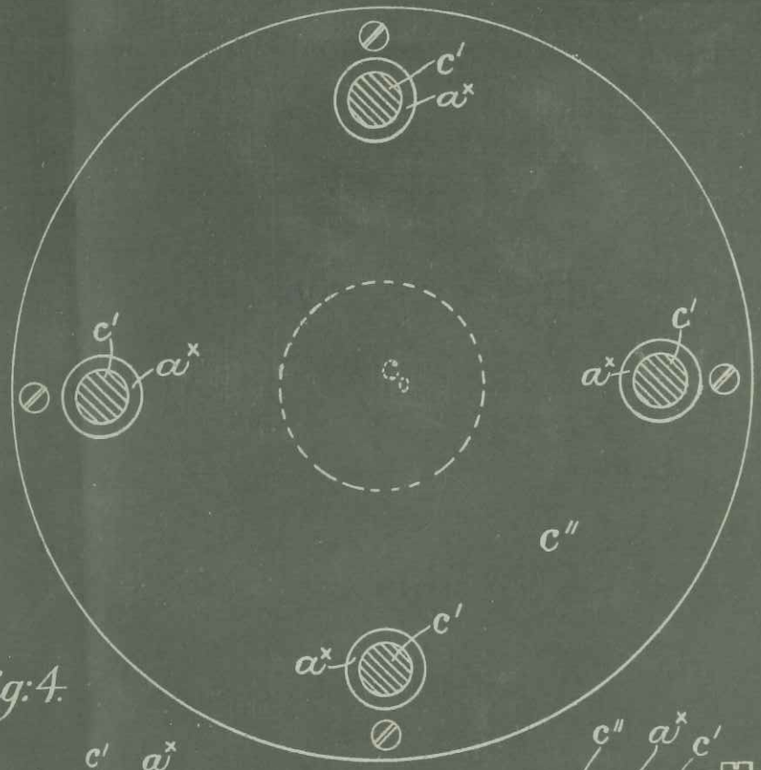
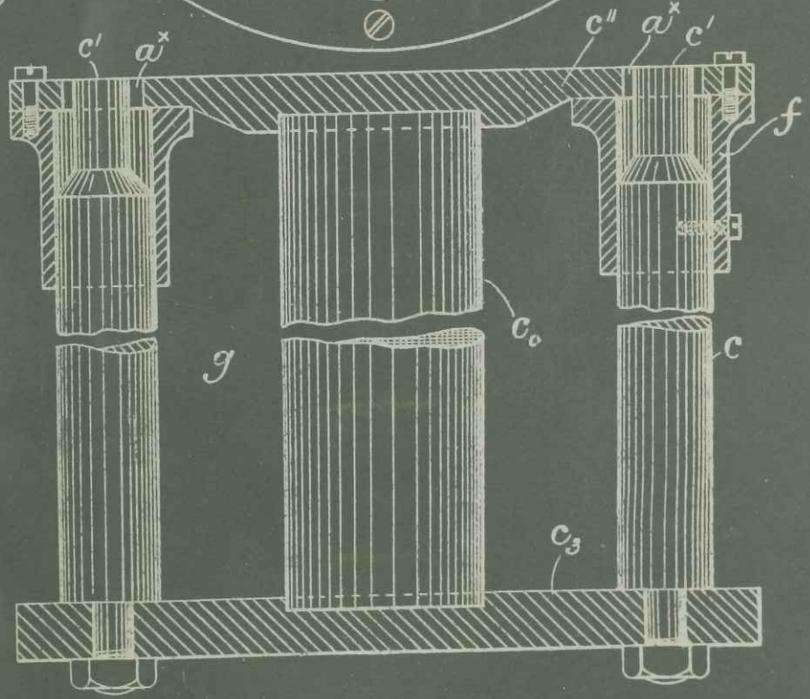


Fig:4.





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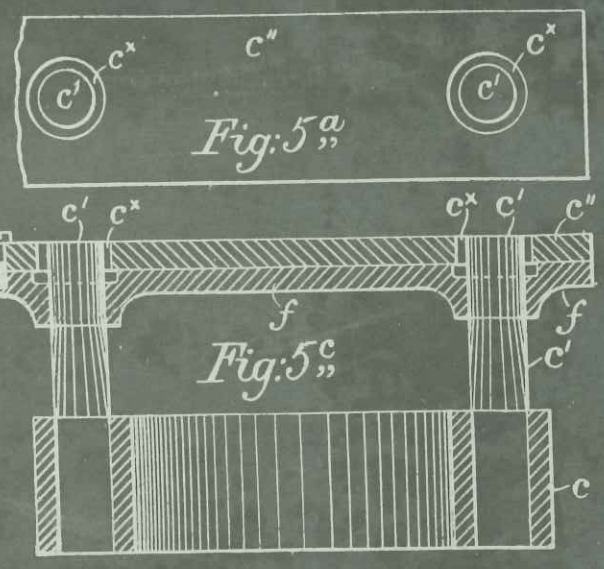
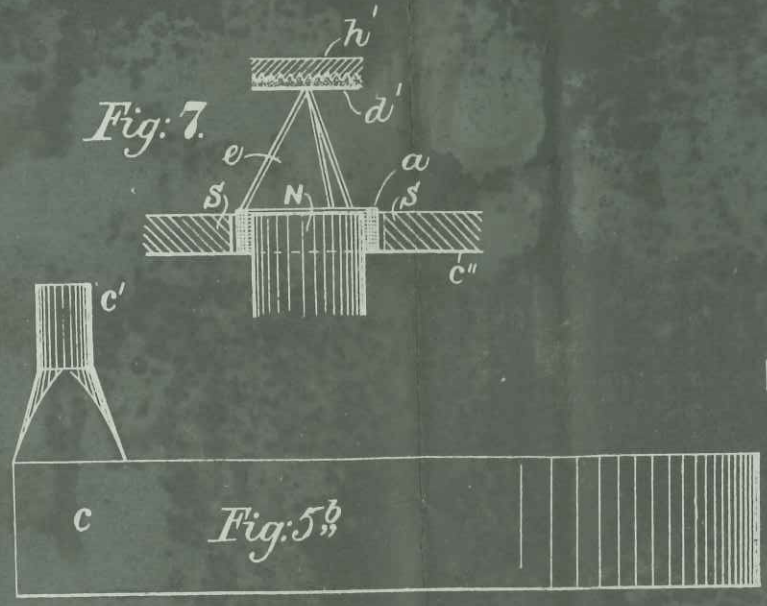
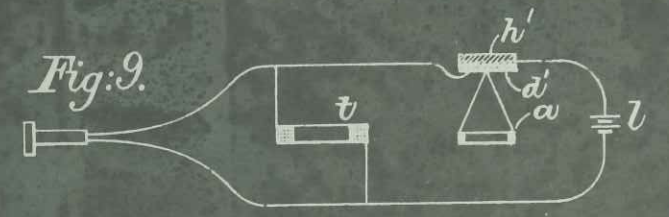
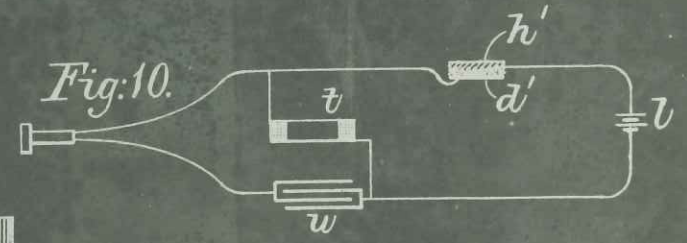
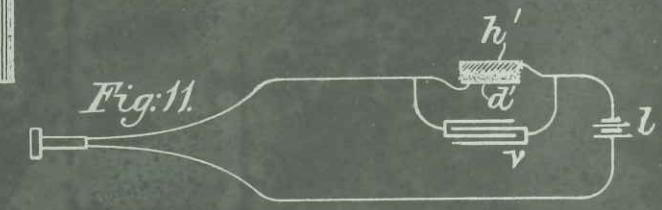










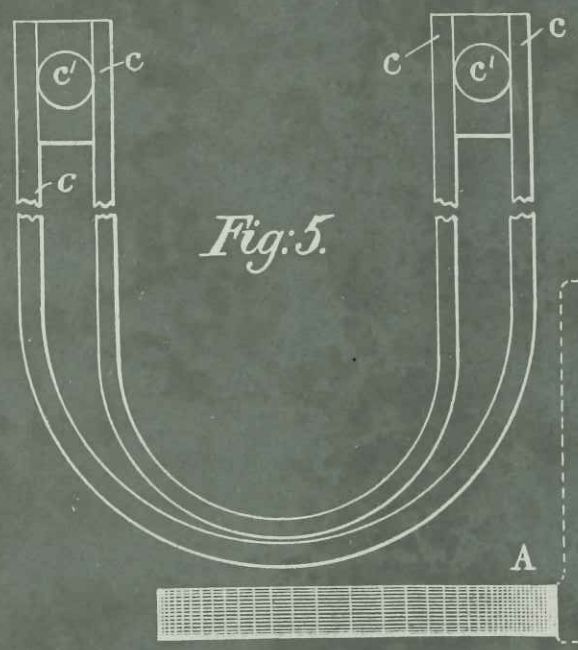
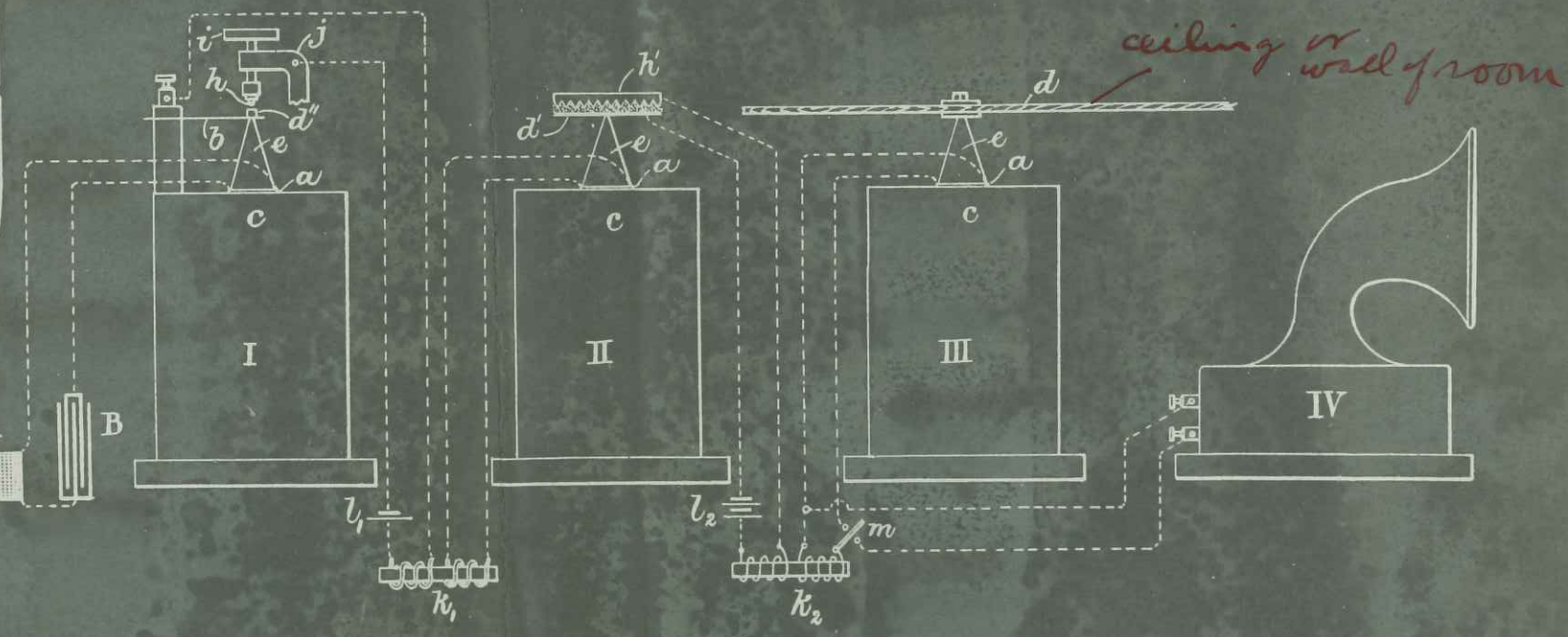
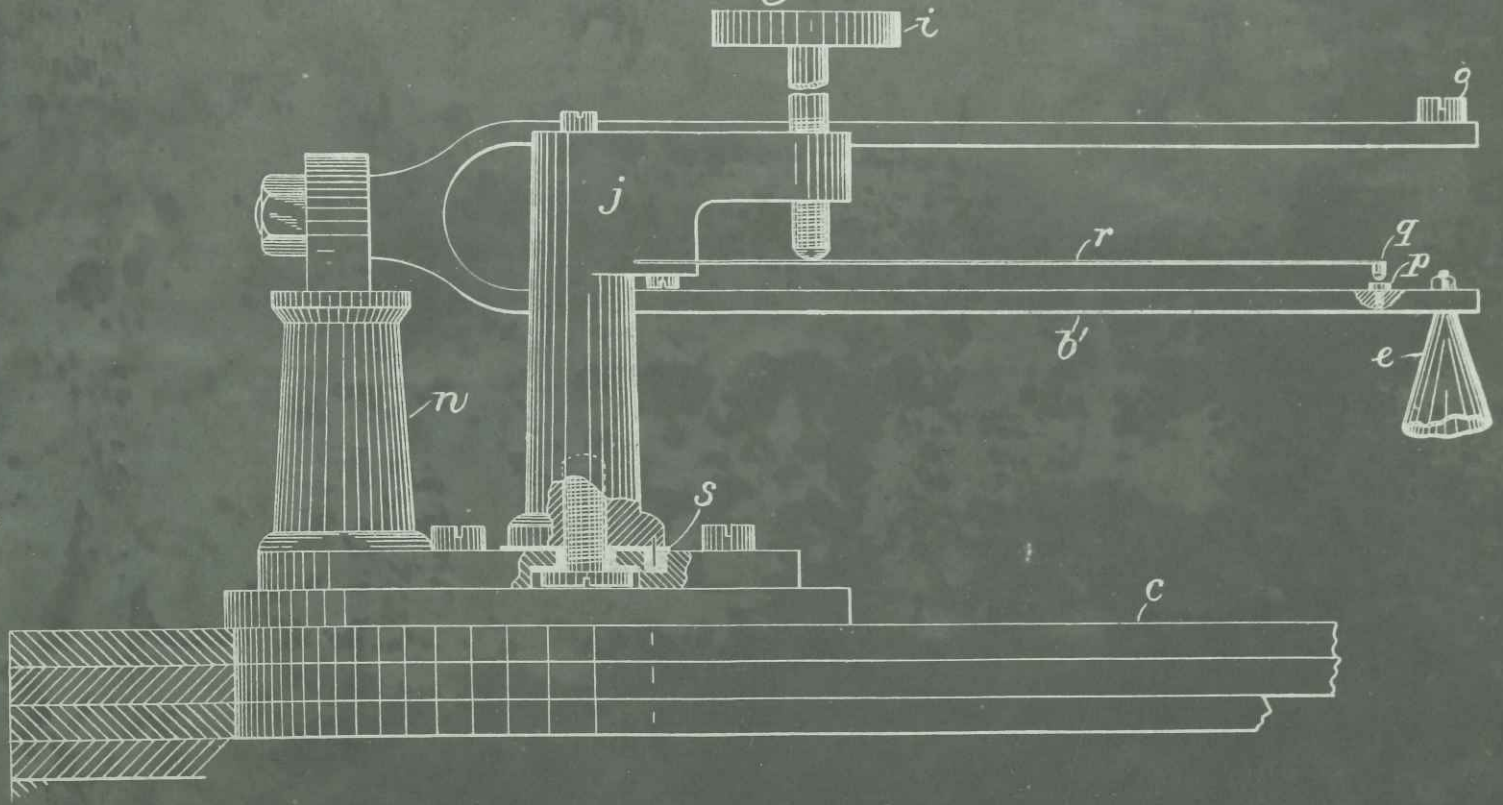


Fig:6.



[This Drawing is a reproduction of the Original on a reduced scale.]

Fig: 8.



Malby & Sons, Photo-Litho.

Also I may use differentially-wound or other transformers for the purpose of communicating electrically between each microphone and the receiving or vibrating coil of the next in the series. The vibrating coils may be wound of fine wire compacted together with cement such as shellac, or they may be of metallic ribbon when extra low resistance is desired.

Furthermore for the purpose of a "call," a tone-telephone such as a tuning fork or other persistent vibrator mounted on a sound board may be employed as the last of the series of telephone relays, so as to respond powerfully when alternating currents of its own frequency are excited at the distant station.

For the purpose of discriminating between a number of call stations a combination of differently attuned forks or tone-telephones may be arranged instead of one, so that each shall respond strongly only to its own note and thus indicate the particular station which is desiring to signal. The receiving or collecting circuit may likewise in some cases be attuned to a definite note. At the sending end a battery connected to an acoustic arrangement, such as a reed, or a string or other rapid intermitter or reverser of current, may be used to stimulate a circuit containing both capacity and self induction, so that it shall be thrown into strong electromagnetic vibration.

Dated this 27th day of April 1898.

A. F. SPOONER,
323, High Holborn, London, Agent for the Applicant.

COMPLETE SPECIFICATION.

Improvements relating to Telephones, and to Circuit Arrangements and Relays therefor.

I, OLIVER JOSEPH LODGE, F.R.S., D.Sc., of 2, Grove Park, Liverpool, in the County of Lancaster, Professor of Physics in University College, Liverpool, aforesaid, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The chief objects of my invention are to provide means for the audible detection of extremely feeble fluctuating electric currents, such for instance as may be caused in a closed, or practically closed, circuit, by another very distant circuit supplied with alternating currents; to magnify the telephonic effect of feeble currents by successive specially-designed relays until the sound is sufficient to act as a "call" summoning the operator to attend to receive the message; to magnify the telephonic effect of speech so that conversation transmitted round one circuit may be heard inductively in a different circuit provided with proper instruments; and generally to improve the conditions under which telephony is carried on so as to magnify every fluctuation of current and thus produce a loud sound from a feeble stimulus for any useful purpose.

For the purpose of detecting or manifesting any feeble alternating or intermittent current, whether excited microphonically or inductively or otherwise, I construct a special kind of telephone or relay, the main features of which are depicted in the annexed drawings. It consists of a coil of insulated wire or metal ribbon a supported freely by an elastic spring b (Figure 3) or by one prong of a tuning fork b^1 (Figure 2) in a strong magnetic field produced by an electromagnet or permanent magnet c of which one pole c^1 is inside the coil while the other pole or keeper c^{11} is outside and surrounding it. The coil is constructed of light materials well cemented or fixed together so as to move as a rigid body, and whenever an alternating current passes round it, it is thrown into bodily vibration, and

transmits these vibrations mechanically to whatever is connected to it. The said coil may be attached in any light and rigid manner to a sound board d (Figure 1) or to the diaphragm d^1 (Figure 7) of a microphonic transmitter, or it may carry a piece of graphite, carbon, or other suitable substance d^{11} (Figures 2 and 3) so that the sound board, the diaphragm, or the carbon, receive the mechanical vibrations.

The object of transmitting the vibrations to the sound board d is to make them directly audible. The object of transmitting them to the microphonic carbon granules or pellet is to actuate a kind of microphonic relay which by throwing into intermittent action the current from a local battery shall greatly magnify the intensity of the originally received disturbance.

The sound-board receiver is depicted in Figure 1, where c is a thin aluminium or other light cone or tripod connecting the vibrating roil a rigidly to the sound board d, which may be of large size and may have a number of similar coils attached to it in various parts. For instance it might form the ceiling or wall of a public hall; and the alternating current originally received by the several coils would in that case be caused by the voice of a speaker directed towards any form of microphonic transmitter capable of distinct articulation.

In the case of Figure 1 the sound board d, or in the case of Figure 7 the diaphragm d^1, itself constitutes the elastic support of the coil a and dispenses with the necessity of the separate spring such as that shown at b in Figure 3. Only one end of the keeper c^{11} is shown in Figures 1 and 2; the side of it is indicated in Figure 3, and it continues to the other pole of the magnet which it similarly surrounds as shown in Figures 5^A and 5^C. In all these figures, the keeper is supported rigidly from the pole by means of a brass collar and plate f.

A form of magnet is shown in Figure 4 (which represents a plan and elevation respectively) where the keeper c^{11} is a round plate of soft iron pierced with holes for the reception of four poles like c^1 and where c_0 is a bundle of hard steel magnets, joined to the four rods c^1 by an iron base plate c_3. Or else, as an alternative arrangement, the whole is of soft iron and the space g surrounding the central shaft is filled with wire, constituting it an electromagnet. Thus a magnet with four pole pieces like c^1 and four annular air gaps or inter pole spaces a^x to receive four vibrating coils such as a shown in the other figures is produced.

Figures 5 and 5^A illustrate in plan; Figure 5^B in side elevation; and Figure 5^C in vertical section, an alternative form of steel magnet and its keeper. The magnet is one of ordinary horseshoe shape with two poles c and soft iron pole pieces c^1 surrounded by a soft iron keeper c^{11} attached rigidly by the brass collar-plate f to the pole pieces.

The coil a instead of being attached to a metal diaphragm held near the ear, or to a sound board as described, may in the first instance be mechanically attached to the diaphragm of a granular microphone as shown in Figure 7 or to some other microphonic arrangement fed by a local battery and having in its circuit (through a transformer or otherwise) another telephone as shown in Figure 6, which may be either of any usual pattern or of the above described new pattern with vibrating coil. This second movable or trembling coil may thus actuate by mechanical means another microphone which, through the energy of its relay battery, may powerfully disturb a third telephone, and this again if necessary a fourth and so on. The whole arrangement is depicted in Figure 6; where the concluding telephone of the series is indicated in two alternative forms either of which may be switched on by the switch m. By this means any required degree of magnification can be obtained, for I find that a coil thus moving as a whole in a magnetic field (otherwise maintained) is very suitable for communicating its tremors to a microphone-transmitter whether of special or of any customary form: being much more effective for this purpose than the ordinary iron diaphragm receiver which vibrates in parts and is under considerable constraint. The final instrument of the series is usually a loud speaking iron disc or diaphragm telephone of some ordinary pattern suitable for imparting vibrations to the air and so on to the ear; or it may

be an electro-dynamometer or a Langdon-Davies phonophoric receiver, or other instrument, for example, that shown in Figure 8, whereby the vibrations are enabled through a relay to work Morse or other telegraph instruments.

I may use this plan of magnification as a call, or as a receiver in magnetic telegraphy, but it is obviously applicable to other useful purposes such as magnifying a speaker's voice by distributing it to various parts of a large hall.

The main features of the microphonic relay or magnifying telephone are shewn in detail in Figures 2 and 3, where the vibrating carbon d^{11} is in light contact (it is shown separated in the figures for clearness) with another piece of carbon or other electric conductor h which is firmly held and adjusted by a thumb screw i working in a suitable support j. It is to be understood that the support j and the spring b or the prong of the tuning fork b^1 are to be connected to a local battery circuit which shall also be connected either directly or through a transformer with the coil of another second receiving telephone. This second telephone thus supplied with intermittent or alternating currents of magnified intensity may be a telephone of ordinary pattern, or it may be a vibratory coil telephone like Figure 1, or it may be another relay telephone like Figures 2 and 3 or like Figure 7 which then in turn magnifies further and operates another telephone, and so on.

Figure 6 serves to show the connexions for such a series of magnifying telephones, or telephone relays. In that figure the coil and condenser indicated at A B represents subject matter described in the Specification of another Application for Letters Patent filed by me and numbered 29,505 dated 13 December 1897, though it may be replaced by any other transmitting or collecting apparatus: for instance this original current fluctuator might be an ordinary microphonic transmitter operated by the voice. The Roman numerals I, II, III and IV represent a possible arrangement of the receiving and magnifying apparatus. No. I is a relay telephone like Figure 2 or Figure 3 with a vibratory coil varying the microphonic contact of the carbons d^{11} and h, one of them being supported by the spring b. No. II is another relay telephone like Figure 7 adapted to stronger currents, with its vibratory coil varying the microphonic contacts in a granular transmitter with its thin carbon diaphragm d^1 and carbon base h^1. No. III is a loud-speaking telephone consisting of a vibratory coil and sound board, like Figure 1. No. IV represents another form of loud-speaking telephone, alternative to the last, where a vibratory diaphragm disturbs the outer air through a concentrating funnel. The magnet in Nos. I II and III is supposed to be an electromagnet shaped like Figure 4, but with only a single air gap surrounding the central shaft C_0 which is wound with a magnetizing helix and surrounded by an outer iron cylinder instead of the four rods c^1 of that figure. The magnet of No. IV is supposed to be more like the horseshoe pattern of Figures 5 to 5°: or it may be any known form of loud-speaking telephone. Electrical connection between I and II and between II and III is effected by means of the transformers k_1 and k_2: l_1 and l_2 are the local batteries, of which l_2 is permissibly stronger than l_1, because of the many contacts in the granular microphone d^1 h^1. Instead however of the speaking telephone No. III a modification called a "call telephone" may be employed. The design of this is depicted in Figure 8 where the coil, suspended as before in a field due to the magnet c by the rigid light connector e, operates the limb of a spring or of a tuning fork b^1 clamped to the pillar u and carrying an adjustable counterpoise o for the purpose of equalizing the load on both prongs, and also permitting a slight range of tuning. The studs p and q are platinum, lightly in contact, the upper one q being held by the thin spring r and adjusted by the thumb screw i. The pillar j supporting this spring is insulated, as for instance by the ebonite s, and thus u and j can be connected to a local battery circuit containing an ordinary relay the tongue of which is just held over by the current across the junction p, q so long as that junction is undisturbed. But directly the fork trembles, the contact between p and q is practically broken or greatly enfeebled, by the dancing of the light spring r on the heavier spring b^1, and accordingly the tongue of the

relay in circuit with p, q (that is with n, j) moves over and completes the circuit of an ordinary electric bell or it may work a Morse instrument.

For the purpose of discriminating between a number of "call" stations a combination of differently attuned forks or tone telephones may be arranged, instead of one, so that each shall respond strongly only to its own note and thus indicate the particular station which is desiring to signal. The receiving or collecting circuit may likewise be attuned to a definite note, as detailed in the specification of my said prior application.

Whether the spring b or the tuning fork b^1 is employed as the elastic support for the coil in any case is optional, but whenever precision of tuning is desired, so that the receiver shall respond to one particular frequency of distant impulses and not to others, I prefer the tuning fork; and in that case it would be preferable to make Nos. I, II and III of Figure 6 all tuning-fork telephones. But where many notes, or where speech is desired to be received and magnified, then either a spring or a diaphragm or some other elastic support can be used. Further I find that a microphone acts best when a certain strength of current is passing through it; so whenever the receiving telephone is of too high resistance to permit this strength of current to flow in simple circuit with it I shunt the telephone by means of a low resistance self-induction or choking coil which conducts the main part of the steady current but diverts the variations of current through the telephone. On a long line a transformer is the natural mode of achieving this object but on a short or purely local line I find the choke shunt preferable.

To enable a fairly strong current to be sent through a microphonic transmitter without over-disturbing a telephonic receiver, I shunt the latter out by a self-induction or choke coil t, as indicated in Figure 9, where the transmitter h^1 is shown operated by one of the vibrating coils a as in Figure 7 but its telephonic receiver is shunted by the coil t, whereby the steady current is mostly conveyed, while its rapid fluctuations mostly go through the telephone. To assist the fluctuation to go through the telephone, I place a condenser u in series with it as shown in Figure 10. This has the effect of strengthening oscillations of some particular frequency in especial, and of all frequencies not too far removed from that.

It is to be understood that the microphone transmitter may be worked by the voice or by any other usual arrangement, and is not limited to the disturbance by attached coils.

Whenever a temporarily inoperative microphone is in circuit with a telephone (as for instance the ordinary transmitter belonging to a local receiver during the reception of a distant message), an accidental noise, a grating or hissing, is usually going on in the telephone. This can be diminished by shunting the telephone with a condenser v, as indicated in Figure 11, an arrangement which is advantageous in some forms of ordinary voice telephones, as it diminishes the disturbing noise from the local transmitter while the desired message from a distant transmitter is being listened to.

This and the other methods mentioned, though specially applicable to such pure-tone-telephony as is appropriate for Morse signals, can also be used with speech-telephony under certain conditions.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A telephone having a coil freely supported in a magnetic field upon an elastic spring or its equivalent substantially as and for the purposes set forth.

2. In a telephone, the combination of a coil freely supported upon an elastic spring or its equivalent with a magnet one pole of which is inside the coil while the other pole is outside and surrounding it substantially as and for the purposes set forth.

3. The method, substantially as set forth, of attaining forcible mechanical or acoustic vibrations from fluctuating electric currents by a telephone consisting

of an elastically suspended movable coil, suspended in an annular or other suitable magnetic field, and connected with a sound board, or its equivalent.

4. The method, substantially as set forth, of magnifying feeble mechanical vibrations electrically received by means of a vibrating coil so arranged as to operate a microphone or microphonic transmitter whose current serves to work another telephone.

5. The combination of a series of telephones and microphones connected alternately electrically and mechanically, so that each telephone receives a disturbance electrically from the preceding microphone and passes it on mechanically in magnified intensity to the next microphone, while each microphone receives a disturbance mechanically from the preceding telephone (or in the case of the first of the series possibly from the voice direct) and passes it on electrically to the next telephone of the series.

6. The microphonic relay or magnifying telephone constructed substantially as described with reference to Figures 2 and 3 of the accompanying drawings.

7. A magnet with one or more inter pole spaces each containing a suspended coil of wire arranged to receive fluctuating currents and thereby to be thrown into vibration substantially as described with reference to Figure 4, or to Figures 5, 5^A, 5^B, and 5^C of the accompanying drawings.

8. As a telephonic "call," a light metallic contact in a local relay circuit arranged so that it dances on an elastic vibrator and thereby changes in electrical resistance when the vibrator is excited by means of fluctuating currents sent round an attached coil suspended in a magnetic field substantially as described with reference to Figure 8 of the accompanying drawings.

9. In a telephonic arrangement, the combination of a magnet, a mechanically vibrating coil surrounding one of its poles, a microphone, and a telephone or its equivalent substantially as and for the purposes set forth.

10. In combination, a tuning-fork or reed and a vibrating coil substantially as and for the purposes set forth.

11. In combination, a tuning fork or reed, a vibrating coil and a loose contact attached to the tuning fork for the purpose of operating a relay and so furnishing a "call" substantially as set forth.

12. In a telephonic circuit the choke coil *t* substantially as and for the purpose set forth.

13. In a telephonic circuit the condenser *v* substantially as and for the purpose set forth.

14. The combination, in a telephonic circuit, of the choke coil *t* and the condenser *u* substantially as and for the purpose set forth.

Dated this 13th day of December 1898.

A. F. SPOONER,
323, High Holborn, London, Agent for the Applicant.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1899.

537